Epidemiologic Study on Work-related Eye Injuries in Kaohsiung, Taiwan

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To describe the epidemiologic features of work-related eye injuries in Kaohsiung, a hospital-based study was performed. Four hundred and eighty-six patients who were treated at emergency service or were admitted to the ophthalmology ward over a 4-year period were reviewed. Among these, 38.9% of eye injuries in the study were work-related. Male workers had a 3.99 higher odds ratio (OR) than females to suffer from eye injuries (95% confidence interval [CI], 1.99–8.04). Most of the work-related eye injuries occurred in subjects who were 30–49 years old (OR, 3.02, and 95% CI, 1.56–5.82, when compared with those aged ≤29 years). The most common type of eye injury in the occupational exposure group was foreign body injury (31.2%), followed by blunt injuries (20.6%), chemical burn (19.6%), UV light radiation (12.7%), and corneal abrasions (11.6%). On the other hand, in the non-occupational exposure group, the most common types of eye injury were blunt injuries (43.4%), corneal abrasions (28.3%), and foreign body injury (20.2%). Our study found that foreign body injury and blunt injuries were the two highest priority injuries for which prevention strategies should be developed in Kaohsiung city. Furthermore, after advanced examination of types of media that caused eye injuries, we found that being hit by wooden objects around the eye, by flying objects in the eye, and by welding flashes are important risk factors for workers to avoid. In conclusion, most of the occupational eye injuries occurred among male workers aged 30–49 years. Due to the lack of an occupational eye injury surveillance system to monitor the incidence of eye injuries and to undertake risk assessment, preventable occupational eye injuries have not been properly controlled. We hope to provide information for further development of preventive strategies.

Key Words: blunt injury, chemical burn, foreign body injury, occupational eye injuries, UV light radiation injury

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Occupational eye injuries are an important public health concern. Most of the injuries occur among productive young workers. This will result in financial losses for employers and workday losses for the community or country. Individually, occupational ocular trauma is a major cause of blindness, which causes the injured worker and his family major financial difficulty. Eye injuries account for 2.9% of all occupational injuries that result in lost workdays in private industry in the United States [1]. More than 2,000 US workers injure their eyes at work each day. Among these, 10–20% of eye injuries cause temporary or permanent vision loss [2]. Although eye injuries are recognized to be an important cause of vision loss, there are relatively few comprehensive studies on the incidence

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and prevention measures of occupational eye injuries worldwide [3–8].

A clustering of corneal ulcer cases in farmers during onion harvest season has been reported in Taiwan [9]. However, no previous studies or official statistical data on work-related eye injuries can be traced. The occupational injuries reporting system of the National Labor Council in Taiwan does not ask employers to report eye injuries. Compensation for work-related eye injuries is categorized among facial injuries (including eye, nose, ear, and mouth injuries). With limited resources to make clear the risk factors of work-related eye injuries, public health workers and researchers have difficulty regarding how to best focus their resources to develop effective prevention programs.

The aim of the current study was to use discharge records of a medical center in Kaohsiung to analyze the risks and preventive factors of work-related eye injuries.

Methods

This hospital-based epidemiologic study was performed using eye injury cases who had visited the emergency department or who had been admitted to an academic medical center in Kaohsiung city. Kaohsiung is Taiwan's second largest city, located in the south of the country. One of the major characteristics of the city is its clustering of heavy industries, including oil refining, steel manufacturing, and ship-building.

The discharge records from January 1, 2001 to December 31, 2004 of the ophthalmology ward and the accident and emergency department showed that 486 patients had been admitted to or had visited the hospital for treatment for eye injuries. Details of the 4-year period of hospital records were reviewed retrospectively. Data extracted from patient records included age, sex, date of admission, cause of admission, clinical diagnosis, media of injuries, and medical cost on discharge.

The criteria for inclusion in our study were age ≥15 years and a major diagnosis of eye injury. The ICD-9 codes which were included in our study were as follows: (1) 870, open wound of ocular adnexa; (2) 871, open wound of eyeball; (3) 918, superficial injury of eye and adnexa; (4) 921, contusion of eye and adnexa; (5) 930, foreign body on external eye; and (6) 940, burn confined to eye and adnexa. Patients re-admitted for treatment of previous eye injuries were excluded.

An ophthalmologist picked out cases of work-related eye injuries after a thorough chart review. Occupation, job and location of accident were extracted from the medical records. For those cases with incomplete data, a trained assistant conducted a telephone interview or home visit to make sure that the injury was indeed work-related. All statistical analyses were performed with SPSS version 13.0 (SPSS Inc., Chicago, IL, USA).

Results

Characteristics of the study subjects

Among the 486 subjects studied, 189 (38.9%) injuries were related to occupational exposure. As shown in Table 1, 173 of 189 (91.5%) in the occupational exposure group were male patients who constituted the majority of occupational eye injuries, while in the non-occupational exposure group, there were 210 (70.7%)

Table 1. Demographic characteristics of occupational and non-occupational eye injury in patient admissions in Kaohsiung city, 2001–2004

	Occupational, *n* (%) 189 (38.9)	Non-occupational, *n* (%) 297 (61.1)	Crude OR (95% CI)	Total, *N* (%) 486 (100.0)
Gender				
Male	173 (91.5)	210 (70.7)	3.99 (1.99–8.04)	383 (78.8)
Female	16 (8.5)	87 (29.3)	1	103 (21.2)
Age (yr)				
≤29	47 (24.9)	121 (40.7)	1	168 (34.6)
30–49	97 (51.3)	98 (33.0)	3.02 (1.56–5.82)	195 (40.1)
≥50	45 (23.8)	78 (26.3)	0.93 (0.49–1.76)	123 (25.3)
Total	189 (100.0)	297 (100.0)	486 (100.0)	

OR = odds ratio; CI = confidence interval.

male patients. The odds ratio (OR) for males to suffer from occupational eye injuries was 3.99 with a 95% confidence interval (CI) of 1.99–8.04 when compared with female subjects.

Over half of the occupational injuries or 97 admissions (51.3%) were aged between 30 and 49 years. On the other hand, patients between 15 and 29 years old comprised the majority of non-occupational injury admissions, at 121 patients (40.7%). When comparing those aged 30–49 years with subjects aged ≤ 29 years, we found that the OR (95% CI) for occupational eye injuries was 3.02 (1.56–5.82). The OR for workers whose age was ≥ 50 years was not significantly different from those aged ≤ 29 years (OR, 0.93; 95% CI, 0.49–1.76).

Types of eye injuries

In the current study, orbital "foreign body" injury was defined as an injury that occurred from anything that got into the cornea or orbit of the eye. As shown in Table 2, the common types of occupational eye injuries in this study were foreign body injury (59, 31.2%), blunt injury (39, 20.6%), chemical burn (37, 19.6%), UV light radiation (24, 12.7%), corneal abrasion (22, 11.6%) and others (8, 4.2%). However, for patients with non-occupational exposure, there were more blunt injuries (129, 43.4%) and corneal abrasion injuries (84, 28.3%). Chi-squared tests showed statistically significant correlations between types of injury and occupational exposure (Table 2).

Media that caused injuries

Table 3 shows the distributions of media that caused eye injuries in both groups. Wooden objects, including wooden construction materials and wood dust, were the most common media for the occupational injury group, with 81 (42.8%) cases, followed by chemicals with 33 (17.5%) cases, metal objects with 31 (16.4%) cases, UV light radiation with 25 (13.2%) cases, and plastic materials with 10 (5.3%) cases. In the non-occupational exposure group, due to incomplete medical records, 127 (42.8%) patients could not be classified clearly. Metal objects, with 118 (39.7%) admissions, were the most common media, followed by 20 cases (6.7%) of wooden objects and 18 (6.1%) of plastic

Table 2. Types of eye injury among patients in Kaohsiung city

	Occupational, *n* (%)	Non-occupational, *n* (%)	Total, *N* (%)	*p**	Data from BLS†
Foreign body injury	59 (31.2)	60 (20.2)	119 (24.5)	< 0.01	15,558 (36.8)
Blunt injury	39 (20.6)	129 (43.4)	168 (34.6)	< 0.001	
Chemical burn	37 (19.6)	24 (8.1)	61 (12.6)	< 0.001	4,811 (11.4)
UV light radiation	24 (12.7)	0 (0.0)	24 (4.9)	< 0.001	2,117 (5.0)
Corneal abrasion	22 (11.6)	84 (28.3)	106 (21.8)	< 0.001	7,365 (17.4)
Others	8 (4.2)	0 (0.0)	8 (1.6)		3,072 (7.3)‡
Total	189 (100.0)	297 (100.0)	486 (100.0)		42,286 (100.0)

*χ^2 test for the correlation between occupational exposure and types of injury; †data from the Bureau of Labor Statistics, US Department of Labor (http://www.bls.gov/opub/cwc/print/sh20040624ar01p1.htm); ‡type of eye injury in the original data source is categorized as "Cut, lacerations".

Table 3. Types of media for eye injury among patients in Kaohsiung city

	Occupational, *n* (%)	Non-occupational, *n* (%)	Total, *N* (%)	*p**
Wooden objects	81 (42.8)	20 (6.7)	101 (20.8)	< 0.001
Chemicals	33 (17.5)	14 (4.7)	47 (9.7)	< 0.001
Iron objects	31 (16.4)	118 (39.7)	149 (30.7)	< 0.001
Electric arc	25 (13.2)	0 (0.0)	25 (5.1)	< 0.001
Plastic objects	10 (5.3)	18 (6.1)	28 (5.8)	NS
Hot liquid	3 (1.6)	0 (0.0)	3 (0.5)	< 0.05
Others†	6 (3.2)	127 (42.8)	133 (27.4)	< 0.001
Total	189 (100.0)	297 (100.0)	486 (100.0)	

*χ^2 test for the correlation between occupational exposure and types of media that caused eye injuries; †patients with non-occupational eye injuries with unclear media that caused eye injuries in their medical records were classified as others. NS = not significant.

Table 4. Distribution of length of stay and average medical costs for patients with eye injuries in Kaohsiung city*

	Occupational, *n* (%)	Non-occupational, *n* (%)	Total, *N* (%)	$p^{\dagger}$
Length of stay (d)				
≤3	43 (22.8)	54 (18.2)	97 (19.9)	
4–7	78 (41.3)	125 (42.1)	203 (41.8)	
8–12	29 (15.3)	72 (24.2)	101 (20.8)	
≥13	39 (20.6)	46 (15.5)	85 (17.5)	NS
Average	8.3±7.5	8.2±6.4	8.3±7.1	NS
Medical costs (NT$)	43,609±30,660	40,449±30,025	42,650±30,443	NS

*Data are presented as *n* (%) or mean ± standard deviation; $^{\dagger}p>0.05$ by χ^2 test or *t* test. NS = not significant.

objects. Chi-squared tests showed statistically significant correlations between types of media that caused injuries and exposure of occupational or non-occupational nature.

Length of stay and medical costs

The distribution of length of stay and average medical cost for the occupational and non-occupational injury groups are shown in Table 4. For the occupational injury group, 8.3±7.5 days was the average length of stay, while it was 8.2±6.4 days for the non-occupational injury group. There was no statistically significant difference in length of stay between the two groups ($t=0.46$, $p>0.05$). The length of stay was most often 4–7 days for both groups (41.3% and 42.1% for the occupational and non-occupational injury groups, respectively). The average medical costs were NT$43,609±30,660 and NT$40,449±30,025 for the occupational and non-occupational injury groups, respectively. Student's *t* test showed no statistically significant difference in average medical costs between the two groups.

Discussion

According to workers' compensation claim data and eye injury registration data analyses in the United States, 20–25% of eye injuries were work-related [7, 10–12]. The percentages of work-related eye injuries were reported to range from 48% to 71% in hospital-based studies using emergency services data [13,14]. In the current study, using data of emergency visits and ophthalmology ward admissions, the percentage of work-related eye injuries (38.9%) is compatible with previous studies. A survey of occupational injuries and illness in private industry workplaces in the US during 2002 reported that 81.0% of men suffered eye injuries and most of these were aged 25–44 years (31.8% in those aged 25–34 years and 30.0% in those aged 35–44 years) [15]. Our data also revealed that workers aged 30–49 years were most prone to be hurt. These results are consistent with previous epidemiologic studies on occupational eye injuries [4,5,7,8]. Meanwhile, from a public health point of view, these injured workers may be the major supporters of their families and also the most productive sector of the workforce, which means that policy makers should put the prevention of occupational eye injuries high on their list of priorities. Employers and even health care providers are not required to report preventable eye injuries in Taiwan. Without a proper surveillance system for the monitoring of the prevalence or incidence of occupational eye injuries, public health workers and researchers are hindered in their efforts to develop effective strategies for the control of eye injuries. A broad-based eye injury databank for further epidemiologic studies is needed to estimate the severity of work-related eye injury problems.

The current study is the first report on the patterns of work-related eye injuries in Taiwan. Injury from foreign bodies, chemical burn, and UV light radiation occur more frequently in the occupational exposure group than in the non-occupational exposure group. On the other hand, blunt injuries and corneal abrasions are the two most common risks of injury for the non-occupational exposure group. This pattern of injury types is compatible with previously reported population-based studies from other countries [3–5,7]. As shown in Table 2, data from the Bureau of Labor Statistics (BLS) of the US Department of Labor showed that the most common type of occupational eye injury was foreign body injury (36.8%), followed by corneal abrasion (17.4%), chemical burns (11.4%), cuts and

lacerations (7.3%), and welder's flash (5.0%) [15]. It seems that blunt injuries were not included in the BLS data. If blunt injuries were excluded from the occupational eye injuries in our study, a strikingly high percentage of chemical burns as well as UV light radiation can be identified. Hence, wearing an eye protection device during work would be a very simple and effective way to reduce occupational eye injuries. Meanwhile, the BLS data showed that most workers were in manufacturing (29.4%), followed by the wholesale and retail trades (22.1%), services (19.9%), and construction (14.9%). However, due to incomplete data collection in the current study, we cannot show the industrial distribution of eye injuries in Taiwan.

After advanced examination of the types of media that caused eye injuries, we found that being hit by wooden objects around the eye, by flying objects such as chemicals in the eye, or by metal and welding flashes could have been easily avoided by wearing eye protection. Through compulsory regulations that require the wearing of eye protection during work, occupational eye injuries can obviously be reduced by a great extent.

There are three large-scale medical centers in Kaohsiung city which are all over 1,000 beds. The health care delivery system in Taiwan does not require patients to obtain care by a referral system. The National Health Insurance program in Taiwan, which covers 98% of the population, allows patients to choose hospital services themselves. Thus, it is difficult for researchers to estimate the catchment areas of service provided and the population covered by the academic medical center. Hence, the estimation of the incidence of work-related eye injuries in the current study is limited.

The average length of stay for both occupational and non-occupational eye injuries was around 8 days, and the average medical costs were about NT$40,449–43,609 (about US$1,250–1,350) in our study. However, due to there being no incidence data in Taiwan, we cannot estimate the economic loss to society at large. We hope that the data from the present study will lead to further studies.

Our study, like most others on occupational eye injuries, was a hospital-based one that can show only the tip of the iceberg in terms of injuries [8,10,11]. Hospital attendees are a non-representative section of the population in terms of wealth, education, and other factors associated with health care access. However, hospital-based studies still permit some generalizations about the relative weight of various causes of injury to be drawn. McCall and Horwitz indicated that hospital-based studies have provided valuable information, all of which inherently creates between-study variability [7].

In summary, work-related eye injury is an important public health problem in Taiwan and elsewhere [1,2,4,5]. The injuries not only result in economic losses for industry but also affect a considerable number of young workers and their families. Although most of the studies have been of a hospital-based epidemiologic nature, each serial eye injury study is important. Through these cooperative efforts, the results will ultimately benefit patients and public health workers for injury control. In this study, we provided valuable insights on the risk factors, types of injuries and media that cause eye injuries for the further development of prevention strategies in southern Taiwan.

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高雄地區職業性眼睛傷害描述性流行病學研究

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台灣地區職業性眼睛傷害的系統性研究目前仍不多，本研究主要目的是：以描述性流行病學分析高雄某醫學中心眼科急診或住院病人，職業性與非職業性眼睛意外傷害的型態與風險因子。收集 2001 年至 2004 年共計 486 個眼睛外傷急診或住院病人分析，發現職業性眼睛傷害占 38.9%，其中男性與女性勞工相比 OR, 3.99 (95% CI, 1.99－8.04)，以年齡而言，職業性眼傷主要年齡為 30－49 歲 (51.3%)，非職業性者則為 15－29 歲 (40.7%)，統計學上，職業性眼傷發生在 30－49 歲的機會為 29 歲 (含) 以下者的 3.02 倍 (OR, 3.02; 95% CI, 1.56－5.82)。主要的職業性眼睛傷害型態包括異物侵入 (31.2%)、外力撞擊 (20.6%)、化學物傷害 (19.6%)、輻射傷害 (12.7%)、角膜擦傷 (11.6%)，非職業性眼傷則以外力撞擊 (43.4%)、角膜擦傷 (28.3%)、和異物侵入 (20.2) 為主。本研究發現：眼睛異物侵入與外力撞擊為兩個最優先需要制定策略加以防治的問題，進一步分析更發現，避免在工作流程中原料、粉塵、或鐵屑的飛噴，與防止工作中被木頭擊中眼臉部等，都是很重要的危險預防因素。我國因尚未建立眼傷通報與監測系統，以致產業界要致力於眼睛意外傷害防治缺乏依據，本研究雖受到個案僅侷限於醫學中心病人之限制，但仍提供傷害類型與風險因子分析，提供未來發展防治政策之需。

關鍵詞：外力撞擊，化學物傷害，異物侵入，職業性眼睛傷害，輻射傷害
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